CLAIMS

1. A scanning probe microscope (10, 50) for imaging a sample (12) in accordance with an interaction between the sample (12) and a probe (20, 54), the microscope (10, 54) comprising

   driving means (16, 18, 22) arranged to provide relative motion between the probe (20, 54) and the sample surface and capable of bringing the sample (12) and probe (20, 54) into close proximity, sufficient for a detectable interaction to be established between them;

   means (22, 52) for oscillating either the probe (20, 54) or the sample (12) in order to provide relative oscillatory motion of the probe (20, 54) across the surface;

   a probe detection mechanism (24, 56, 58) arranged to measure at least one parameter indicative of the strength of the interaction between th probe (20, 54) and the sample (12); and

   a feedback mechanism (26) arranged to provide for adjustment of probe – sample separation via operation of the driving means (16, 22) in response to a variation in an average value of one of the at least one parameters away from a predetermined set value;

   characterised in that, the microscope (10, 50) is arranged, in operation, to carry out a scan of the sample surface wherein scan area is covered by an arrangement of scan lines, each scan line being collected by oscillating either the probe (20, 54) or the sample (12) at or near its resonant frequency such that oscillation amplitude determines maximum scan line length and their arrangement is provided by operation of the driving means (16, 22).

2. A microscope according to claim 1 characterised in that the probe is metallic and the parameter indicative of the interaction is capacitance of an interface between probe and sample.

3. A microscope according to claim 1 characterised in that the parameter indicative of the interaction is oscillation amplitude.

4. A microscope according to claim 2 characterised in that a second parameter indicative of the interaction, and the one on which the feedback mechanism (26) operates, is oscillation amplitude.

5. A microscope according to claim 2 or 4 characterised in that the probe detection mechanism (24, 56, 58) comprises a modulation signal generator (48) arranged to apply a modulating voltage across the interface between probe (20, 54) and sample (12) in order to modulate its characteristics and thereby to affect its electrical capacitance, a resonator (42) arranged to set up a resonating electric field in a circuit incorporating the probe (20, 54) and sample (12) and a detector (46) arranged to measure the electric field resonant frequency and thereby to enable variations in the capacitance of the interface to be measured as the modulating voltage is applied.

6. A microscope according to claim 1 characterised in that the probe (20) is adapted to interact with a magnetic field and the probe detection mechanism (24, 56, 58) is arranged to measure a parameter indicative of the magnetic interaction between the probe (20, 52) and the sample (12).

7. A microscope according to claim 1 characterised in that the probe (20) comprises a cantilever and actuator arranged to drive the cantilever in a "tapping" mode.

8. A microscope according to claim 7 characterised in that the parameter

indicative of the strength of the interaction is bending of the cantilev r as it taps the sample (12).

9. A microscope according to claim 1 characterised in that the probe (54) is an AFM cantilever and the one of the at least one parameter indicative of the strength of the interaction that is measured by the probe detection mechanism (24, 56, 58) and used by the feedback mechanism (26) is bending of the probe (54).

10. A microscope according to claim 9 characterised in that the probe detection mechanism (24, 56, 58) comprises an interaction detection mechanism (56) arranged to measure at least one parameter indicative of the strength of the interaction between the probe (54) and the sample (12) and a deflection detection mechanism (58), the deflection detection mechanism being linked to the feedback mechanism (26) and arranged to measure bending of the probe (54).

11. A microscope according to claim 9 or 10 characterised in that the probe (54) comprises an actuator arranged to drive the cantilever in "tapping" mode.

12. A microscope according to any preceding claim characterised in that the driving means (22) is arranged to oscillate the probe (20).

13. A microscope according to claim 12 characterised in that the driving means (22) includes a tuning fork.

14. A microscope according to any one of claims 1 to 11 characterised in that the means for oscillating (22, 52) either the probe or the sample is arranged to oscillate the sample (12).

15. A microscope according to claim 14 characterised in that the means for oscillating the sample is a tuning fork (52) and the sample (12) is

attached thereto.

16. A microscope according to any preceding claim characterised in that the feedback mechanism (26) operates with a time constant which is greater than one cycle of probe oscillation and significantly less than total time taken to perform a scan.

17. A microscope according to claim 12 or 13 characterised in that the probe is oriented substantially vertically and the driving means (16, 22) is arranged to provide a relative linear translation of probe (20) and sample (12) in a direction substantially orthogonal to a plane in which the probe is oscillated, thereby defining a substantially rectangular scan area.

18. A microscope according to claim 12 or 13 characterised in that the probe is oriented substantially horizontally and the driving means (16, 22) is arranged to provide a relative linear translation of probe (20) and sample (12) in a direction substantially parallel to the oscillation axis, thereby defining a substantially rectangular scan area.

19. A microscope according to claim 12 or 13 characterised in that the probe is oriented substantially vertically and the driving means (16, 22) is arranged to provide a relative rotation of probe (20) and sample (12) about an axis substantially coincident with that about which the probe (20) is oscillated, thereby covering the scan area by a circular arrangement of scan lines.

20. A microscope according to any preceding claim, the microscope being adapted to monitor charge distribution in a semiconductor device.

21. A method of rapidly collecting image data from a scan area of a sample (12) with nanometric features wherein the method comprises the st ps of:-

(a) Moving a probe (20, 54) with tip of sub-nanometric dimensions into close proximity with a sample (12) in order to allow an interaction to be established between probe (20, 54) and sample (12);

(b) Oscillating either the probe (20, 54) across the surface of the sample (12) at or near its resonant frequency or the sample (12) beneath the probe (20, 54) at or near its resonant frequency whilst providing a relative motion between the probe (20, 54) and surface such that an arrangement of scan lines, whose maximum length is determined by oscillation amplitude, covers the scan area;

(c) Measuring a parameter indicative of the interaction strength;

(d) Monitoring the parameter measured in step (c) or a second parameter which is also indicative of an interaction between probe (20, 54) and sample (12) and, if a value of the monitored parameter falls below or rises above a predetermined set value, adjusting probe (20, 54) – sample (12) separation distance in order to drive the value of the monitored parameter back towards the set value; and

(e) Processing measurements taken at step (c) in order to extract information relating to the nanometric structure of the sample.

22. A scanning probe microscope for writing information to a sample by means of a periodic interaction between the sample and an AFM cantilever probe, the microscope comprising

driving means arranged to provide relative motion between the probe and the sample surface and capable of bringing the sample and probe into close proximity;

means for oscillating either the probe or the sample in order to provide relative oscillatory motion of the probe across the surface;

a probe writing mechanism arranged to generate a periodic interaction force between the probe and the sample and so change a property of the sample surface in the locality of the probe;

characterised in that, the microscope is arranged, in operation, to carry out a scan of the sample surface wherein scan area is covered by an arrangement of scan lines, each scan line being collected by oscillating either the probe or the sample at or near its resonant frequency such that oscillation amplitude determines maximum scan line length and their arrangement is provided by operation of the driving means.